PATENT SPECIFICATION

DRAWINGS ATTACHED

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848,988

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COMPLETE SPECIFICATION

An improved Tank Gauging Apparatus

We, JOHN LAMB PUBLICATIONS AND INVENTIONS LIMITED, a British Company, of 33, Baker Street, London, W.1 (formerly of 44/45, Billiter Buildings, Billiter Street, London, E.C.3), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for measuring the height of liquid in tanks and other like containers. For example apparatus according to the invention may register continuously on a scale the height of the free surface of liquid in a tank or other container. The invention is especially, though not exclusively, applicable to the ullaging of cargo compartments of oil tankers and liquid fuel bunker compartments of all classes of ships.

Tank gauging apparatus commonly used at present makes use of a metal tape with a float attached to its lower end and the present common practice in ullaging, i.e. ascertaining the liquid level, of oil tanks is to lower the float attached to one end of the tape measure through an opening in the top of the tank the ullage of which is required. This technique affords an opportunity for the escape of oil vapour from the tank and in cases where the liquid is of a volatile nature such escape presents a risk of fire as well as the possibility of the operator holding the tape being overcome by the gas.

It is an object of the present invention to provide gauging apparatus so adapted that escape of gas is reduced to a minimum, and which will automatically and continuously register the varying liquid level in a tank which is being filled or emptied. This is of considerable importance in oil tankers where the filling rate may be as high as a one foot rise in three minutes.

At the end of the filling operation of an oil tanker there is a danger of the tank overflowing with consequent pollution of harbours and risk of fire unless the liquid level is constantly observed. Overflowing of a tank is more likely to be avoided if the liquid level is registered automatically and if the operator is not exposed to escaping gas.

The present practice when loading oil tankers is to slow down the filling of a tank when the ullage is about eight feet and then to keep the level of the oil under observation by the tape measure at such frequent intervals that the operation becomes almost continuous.

The reason for reducing the filling rate is the fear that the tank will overflow, so that if the liquid level could be observed at any moment on a scale the need for this would be eliminated and the time taken to fill a tank to the desired ullage greatly reduced, with a consequent reduction of the time a ship must remain in port.

The apparatus according to the invention comprises a system of drums and pulleys contained on a frame within an outer casing and a float attached to the free end of a graduated steel or plastic tape, the other end of which is attached to the pulley upon which it is wound.

The float, which is buoyant in liquid having a specific gravity of between 0.65 and 1.0, may be of such a size that it will pass freely through the standard ullage pipe of oil tankers, and the lower end of the outer casing is designed to fit into the top of the ullage pipe and to be clamped or otherwise secured in such a manner as to form a gas-tight joint, for example by quick acting clips.

The weight of an entire apparatus according to the invention may be about 15 lb. so that it is easily transportable. The float may be attached to the graduated tape by a snap clip or other quick acting coupling so that the float can, if required, be readily separated to facilitate transfer of the apparatus from one tank to another. Alternatively the tape may be permanently attached to the float as by riveting.

According to the present invention we provide tank gauging apparatus for continuously registering the height of the surface of a

liquid in a tank comprising a graduated flexible tape adapted to be extended down into the tank, a float at the lower end of the tape to rest upon the surface of the liquid so that it moves up or down as the tank is filled or emptied, a tape supply reel upon which the tape is wound and a power reel carrying a substantially constant force spring formed of strip spring material coiled upon the power reel and adapted to exert a substantially constant force on the tape irrespective of the position of the float and the amount of tape which has been unwound so that no slackness occurs in the tape whereby changes in liquid level may be continuously indicated by the amount of tape which remains unwound at any given moment.

In order that the invention may be clearly understood it will now be described more fully, by way of example, and with reference to the accompanying drawings illustrating one example in which:—

Figure 1 is a central vertical section of a tank gauging apparatus according to the invention, parts of the apparatus being shown in elevation;

Figure 2 is a sectional plan on line II—II of Figure 1;

Figure 3 is a vertical sectional view on line III—III of Figure 1 with the upper part shown partly as an end view with one end plate of the frame removed;

Figure 4 is a partial sectional elevation of the apparatus fitted to a tank and showing the guiding means for the float;

Figure 5 is a plan on line V—V of Figure 4, the upper part of the gauging apparatus having been removed, and

Figure 6 is a section on line VI—VI of Figure 4.

Referring to the drawings, a casing 1 of light weight material such as aluminium alloy or a suitable plastic is formed with a flange 1A and a nipple 1B for the attachment of the apparatus to the usual tank ullage stand pipe 2, Figure 4, and to form a gas-tight connection therefore. Clips 15 may be used to secure the apparatus to the stand pipe, instead of using a threaded nipple. The casing may also have a removable cover plate 1C to enable access to be had to mechanism within the casing. Secured to the casing by studs 3 is a rigid frame 3A comprising side plates 3B, 3C and end plates 3D, the plate 3C being removable. Mounted in a low friction bearing 4 in the plate 3B and in a bearing in the plate 3C is a shaft 4A to which is keyed a tape reel 4B. The shaft is extended through the casing and is furnished with a winding handle 4C. Also keyed to the shaft is a power reel 5. Mounted on a shaft 5A and having bearings in the side plates is a further reel 5B. These reels 5 and 5B together with a steel spring (not shown) which can be wound or unwound on the reels, constitute a device adapted to exert a substantially constant force, preferably that known under the Registered Trade Mark "Tensator" made by Messrs. Tensator Ltd. of London, N.W.10. The free end of the substantially constant force spring is doubled back against its natural curvature and is attached by a screw to the power reel. The operation of the substantially constant force spring will later be described.

The inner end of a graduated tape 6, which may be made of steel or a suitable plastic, is attached to the tape reel 4B by a screw 6A. The tape is wound on the tape reel and is passed over two pulleys 6B and 6C in order to centralise it with respect to the nipple 1B and the ullage stand pipe 2. It will be seen that the tape will remain centralised irrespective of the amount of tape wound on the tape reel. Secured to the free end of the tape by a clip 7 is a float 7A. The snap clip enables the float to be readily separated from the tape so that the apparatus may be transferred from one tank to another. Alternatively a protecting sleeve 14 may be attached to the nipple 1B, being long enough to protect the float when the apparatus is stood on the deck. The float is buoyant in liquids having a specific gravity of between 0.65 and 1.0 and is of such a size that it will pass freely through the ullage stand-pipe.

The pulleys 6B and 6C are positioned so that the tape runs parallel and close to a window 7B through which the graduations on the tape may be viewed. A slidable scale may be provided, parallel to the window, which scale may be adjusted to zero reading according to the specific gravity of the liquid being ullaged. The window may have a projection 7C to enable it to be withdrawn for cleaning.

The tape passes from the pulley 6C into the tank to be ullaged through a felt scraper 8 which serves to remove from the tape any liquid adhering to it as the float is raised either by the level of the liquid rising or when the tape is wound on the reel by the operation of the winding handle 4C. Since the felt scraper 8 also acts as a seal, the leakage of gas from the tank into the apparatus is prevented, making it possible to pull out the sliding window without gas escaping from the tank.

The substantially constant force spring imparts a rotary motion to the tape reel 4B as the float is lifted by the rising level of the liquid in the tank. A special feature of this spring is that the force required to unwind it remains constant over its entire range with a slight increase in tension to compensate for the weight of the tape, and consequently, the upward force on the float through the tape is uniform over a float travel of at least 65 feet. This makes for accurate registering of the liquid level.

Since the reels and tape pulleys are all mounted within the rigid frame 3A, it is only

necessary to free the studs 3 and to remove the winding handle to permit the frame to be withdrawn from the casing, the removable cover plate 1C enabling this to be done.

If not restrained, the float would tend to wander out of line with the apparatus and give a false reading of the liquid level. This may be prevented by providing guide wires 9, Figure 4, between which the float may move up and down. These guide wires may be permanently fitted in the tank and may comprise six equal lengths of stainless steel or other suitable metal. The upper end of each wire is bent at a right angle and is lodged in a radial slot 9A formed in a metal ring 9B which is clamped between the tank wall 9C and the ullage stand-pipe 2, by bolts 9D. The lower ends of the wires are welded or otherwise secured in slots 10 in a metal cylinder 10A, the arrangement being such that an unobstructed passage is provided for the float in its travel. The cylinder is suspended by the wires so that it is about one inch from the bottom of the tank so that any change in temperature, or upward movement of the tank, will not affect the tension of the guide wires, the tension being due to the weight of the cylinder. In order to prevent the cylinder and its attached wire guides moving out of alignment with the ullage stand-pipe, side movement of the cylinder may be prevented by three brackets 11 welded to the bottom of the tank.

The action of the apparatus, assuming that it has been connected to an ullage stand-pipe, is as follows:—

Assuming that a tank is 98% full of water of specific gravity 1.0 when the float is lowered until it floats, the rate of fall of the float being controlled by the handle 4C then, when the float comes to rest the reading on the graduated tape is noted and this reading will represent "No ullage", in water. In the case of liquids of lower specific gravity the float will, of course, float more deeply and a correction for specific gravity will require to be made. The height at which flotation occurs in liquids of different specific gravity is indicated on the side of the float and, by adjusting the specific gravity scale, the correct ullage will be shown on the tape. As the liquid level in the tank falls, the float will maintain its relative position, and in proceeding downwards with the liquid level will cause the graduated tape to be unwound, with the result that a pull is exerted on the tape reel 4B. As the power reel 5 is fixed to the tape reel rotation of the latter will cause the substantially constant force spring to unwind from the power reel 5 and be wound upon the reel 5B. When the liquid level rises with the float, the effect of the substantially constant force spring is to maintain a light but uniform pull on the tape so that no slackness occurs and the ullage is accurately registered at all depths.

Since the weight of the entire apparatus may be about 15 lb. it is easily transportable and to enable it to be carried it may be furnished with a handle 12. In order to lock the tape reel when required the shaft 4A may have a removable pin 13 which engages a stud 13A secured to the casing 1.

The invention has been described more particularly in relation to oil tankers, but naturally, it may be used with advantage in connection with other tanks or containers and with liquids other than oil.

In the above described apparatus the winch handle is an integral part of its spindle and of the two pulleys which act as the substantially constant force spring power pulley and the tape supply pulley. This means that when the float is automatically following rising or falling of a liquid in the tank, there may be a lag in the position of the float due to friction between the handle spindle and its gas-tight bearing gland, and there may be an oscillating or varying error due to the unbalanced weight of the handle. To overcome this where necessary we may provide means for preventing any stiffness or unbalanced weight of the winding handle from affecting the sensitivity of indication of ullage when the float is automatically following changes of level of the tank's contents. To describe such an example reference will now be made to the following drawings in which:—

Figure 7 is a sectional side elevation;

Figure 8 is a vertical section of Figure 7;

Figure 9 is a horizontal section of Figure 7;

Figure 10 is an enlarged section of the spring pulley;

Figure 11 is an enlarged section of the handle spindle clutch and pulley, and

Figure 12 is a detail plan view of the clutch.

In Figures 7 to 12, a frame 101 comprises a base pad 102 for coupling to a coupling flange 103 and a vertically disposed plate upon which the pulleys are mounted on stub axles, 105 and 106.

A split cover 107 is mounted on the frame in such a way as to prevent other than a negligible escape of gas or vapour from the tank through the winch to atmosphere. If required the cover may be connected to the frame by means of seals and gaskets so that it is completely gas tight. A gas and dust seal 108A of known type also surrounds one end of the handle spindle 108.

The handle spindle 108 drives, through the hollow centre of the stub axle 105, the power pulley 109 and the tape supply pulley 110 by means of a clutch plate 111 carried at its inner end. This clutch plate has an inwardly facing flange 112 near its periphery and the flange is slotted radially either with an L-shaped slot or for convenience in machining with a T-shaped slot 113. By sliding the handle spindle axially, the slot in the clutch plate may be made to engage or disengage two flanged pins 114 which project from one

face of the power pulley.

When engaged, the clutch cannot be disengaged so long as the load of the float is tending to rotate the handle spindle against the manual torque on the handle exerted by the operator. It can be disengaged only when the float is held in its uppermost position by operating a tape lock 115, or, more important, when the float is floating on the surface of the tank liquid

As in the first example, the movement of the level of tank liquid is followed by movement of the float which movement is measured by reading the graduated ullage tape. In this example, however, this movement of the float is less affected by friction of the moving parts of the winch and by other possible small errors, principally because while the movement is occurring, the handle spindle 108 is declutched from the mechanism.

Further to minimise friction of moving parts and thereby to improve accuracy, each of the stub axles 105 and 106 and of the stub axles for pulleys 104, carries two angular-contact type ball races such as 116 and 117, 118 and 119 which can be adjusted for example by means of shims or distance pieces between the inner or outer races to give minimum friction without shake.

WHAT WE CLAIM IS:—

1. Tank gauging apparatus for continuously registering the height of the surface of a liquid in a tank comprising a graduated flexible tape adapted to be extended down into the tank, a float at the lower end of the tape to rest upon the surface of the liquid so that it moves up or down as the tank is filled or emptied, a tape supply reel upon which the tape is wound and a power reel carrying a substantially constant force spring formed of strip spring material coiled upon the power reel and adapted to exert a substantially constant force on the tape irrespective of the position of the float and the amount of tape which has been unwound so that no slackness occurs in the tape whereby changes in liquid level may be continuously indicated by the amount of tape which remains unwound at any given moment.

2. Tank gauging apparatus comprising two reels, a power reel and a free reel, on which reels a substantially constant force spring is wound or unwound, a tape supply reel upon which a graduated flexible tape is wound, two guide pulleys over which the tape passes so that the graduations on the tape can be seen through a window, a float attached to the tape and a sliding scale parallel with the window which scale can be adjusted to zero reading according to the specific gravity of the liquid in the tank, the arrangement being such that the tape is at all times maintained in a taught condition by the force exerted by the spring irrespective of how much tape has been unwound.

3. Apparatus according to claim 2, wherein the reels and pulleys are housed in a casing which is adapted to be removably connected to an ullage stand-pipe.

4. Apparatus according to claim 3, wherein the casing for the reels and pulleys is substantially gas tight.

5. Apparatus according to claim 3 or 4, wherein the tape passes through a scraper which also provides a substantially gas-tight seal between the interior of the casing and the ullage pipe.

6. Apparatus according to any one of the preceding claims wherein means are provided for guiding the float during its movements.

7. Apparatus according to claim 6, wherein the aforesaid means comprises a plurality of fixed wires which are so spaced one from the other that they define a circular space which aligns with the bore of an ullage stand-pipe.

8. Apparatus according to any of the preceding claims wherein the float is secured to the tape by a releasable clip such as a snap clip.

9. Apparatus according to any of the preceding claims wherein clips are used to secure the apparatus to a stand-pipe.

10. Apparatus according to any of the preceding claims characterised by the provision of a winding handle having a spindle extending through the hollow centre of a stub axle which freely supports the power pulley and the tape supply pulley which is driven through the medium of a clutch plate at the inner end of the spindle.

11. Apparatus according to claim 10 wherein the clutch plate has an inwardly facing flange near to its periphery, the flange being slotted radially for example by an L-shaped or a T-shaped slot adapted to be engaged by flanged pins projecting from the power pulley.

12. Tank gauging apparatus substantially as herein described with reference to any of the figures of the accompanying drawings.

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Agents for the Applicants.

PROVISIONAL SPECIFICATION

An improved Tank Gauging Apparatus

We, JOHN LAMB PUBLICATIONS AND INVENTIONS LIMITED, a British Company, of 44/45, Billiter Buildings, Billiter Street, London, E.C.3, do hereby declare this invention to be described in the following statement:—

This invention relates to apparatus for

measuring the height of liquid in tanks and other like containers. For example apparatus according to the invention may register continuously on a scale the height of the free surface of liquid in a tank or other container. The invention is especially, though not exclusively, applicable to the ullaging of cargo compartments of oil tankers and liquid fuel bunker compartments of all classes of ships.

Tank gauging apparatus commonly used at present makes use of a metal tape with a float attached to its lower end and the present common practice in ullaging, i.e. ascertaining the liquid level, of oil tanks is to lower the float attached to one end of the tape measure through an opening in the top of the tank the ullage of which is required. This technique affords an opportunity for the escape of oil vapour from the tank and in cases where the liquid is of a volatile nature such escape presents a risk of fire as well as the possibility of the operator holding the tape being overcome by the gas.

It is an object of the present invention to provide gauging apparatus so adapted that escape of gas is reduced to a minimum, and which will automatically and continuously register the varying liquid level in a tank which is being filled or emptied. This is of considerable importance in oil tankers where the filling rate may be as high as a one foot rise in three minutes.

At the end of the filling operation of an oil tanker there is a danger of the tank overflowing with consequent pollution of harbours and risk of fire unless the liquid level is constantly observed. Overflowing of a tank is more likely to be avoided if the liquid level is registered automatically and if the operator is not exposed to escaping gas.

The present practice when loading oil tankers is to slow down the filling of a tank when the ullage is about eight feet and then to keep the level of the oil under observation by the tape measure at such frequent intervals that the operation becomes almost continuous.

The reason for reducing the filling rate is the fear that the tank will overflow, so that if the liquid level could be observed at any moment on a scale the need for this would be eliminated and the time taken to fill a tank to the desired ullage greatly reduced, with a consequent reduction of the time a ship must remain in port.

The apparatus according to the invention comprises a system of drums and pulleys contained in a frame within an outer casing and a float attached to the free end of a graduated steel or plastic tape, the other end of which is attached to the pulley upon which it is wound.

The float, which is buoyant in liquid having a specific gravity of between 0.65 and 1.0, is of such a size that it will pass freely through the standard ullage pipe of oil tankers, and the lower end of the outer casing is designed to screw into the top of the ullage pipe in such a manner as to form a gas-tight joint.

The weight of an entire apparatus according to the invention may be less than 10 lbs. so that it is easily transportable. The float may be attached to the graduated tape by a snap clip so that the float can, if required, be readily separated to facilitate transfer of the apparatus from one tank to another.

According to the present invention we provide tank gauging apparatus for registering the height of the surface of a liquid in a tank comprising a flexible tape adapted to be extended down into the tank, a float at the lower end of the tape to rest upon the surface of the liquid so that it moves up or down as the tank is filled or emptied, a tape supply reel upon which the tape is wound and a power reel carrying a constant force spring formed of strip spring material coiled upon the power reel and adapted to exert a substantially constant force irrespective of the position of the float and the amount of tape which has been unwound whereby changes in liquid level may be continuously indicated by the amount of tape which remains unwound at any given moment.

One apparatus, embodying the invention described as an example, comprises two reels, a power reel and a free reel, on which a constant force spring is wound or unwound, a tape supply reel upon which the graduated tape is wound, two guide pulleys over which the tape passes so that the figures on the tape can be seen through a window, a float and a slidable scale parallel with the window which can be adjusted to zero reading according to the specific gravity of the liquid.

The tape passes from the apparatus into the tank to be ullaged through a felt scraper, the purpose of which is to remove from the tape any liquid adhering to it as the float is raised either by the level of the liquid rising or when the tape is wound on the tape reel by operation of a crank handle. This construction also reduces to a minimum the area of opening for the passage of gas from the tank to the inside of the apparatus, so it is possible to pull out the slidable window for cleaning without gas in quantity escaping from the tank.

The constant force spring may be a "Tensator" spring made by Messrs. Tensator Ltd. of London, N.W.10, which is used to give rotary motion to the tape reel as the float is lifted by the rising level of the liquid in the tank. The special feature of the constant force spring is that the force required to unwind it remains constant over its entire range with a slight increase in tension to compensate for the weight of tape, and consequently, the upward force on the float through the tape is uniform over a float travel of at least 65 feet. This makes for accurate registering of the liquid level.

The power reel (the reel upon which the spring is wound when the float is at its highest position) may be fixed to a shaft which is suspended between two ball or like bearings housed in the rigid frame. The free end of the constant force spring is doubled back against its natural curvature and attached by means of a screw to the power reel of the spring which is secured to the tape reel and revolves with it. The tape reel is suspended similarly and the end of the shaft to which it is fixed has one end shaped to take the winding handle.

The inner end of the graduated tape is attached to the tape reel by a screw and upon leaving this reel the tape passes over two small pulleys to bring it into line with the opening into the tank and make it independent of the amount of tape unwound. Also, as already mentioned, this arrangement enables the figures on the tape to be seen through the window situated in the most convenient position.

Ball or like bearings are used for both shafts as it is essential that the frictional resistance offered to these moving parts should be the minimum.

The power reel, tape reel and guide pulleys are all preferably mounted within a rigid frame and can be readily removed from the outer casing, which can be made of some light weight material such as aluminium alloy or plastic. One side of the casing may be removable for this purpose.

If not restrained the float would tend to wander out of line with the apparatus and give a false reading of the liquid level. This may be prevented according to a feature of the invention by providing guide wires between which the float may move up and down. These guide wires may be permanently fitted in the tank and may consist of six equal lengths of stainless steel or other suitable metal.

The upper end of each wire may be firmly secured to a steel ring which is disposed between the top of the tank and the ullage standpipe. The lower ends are attached to a metal cylinder which ensures the wires being kept under a state of tension. This cylinder is suspended about one inch from the bottom of the tank so that any change in temperature, or upward movement of the bottom of the tank, will not affect the tension in the guide wires. To prevent the cylinder, and consequently the float guide wires, moving out of alignment with the ullage stand-pipe, side movement of the cylinder may be prevented by three brackets welded to the bottom of the tank.

The action of the apparatus, which we will assume has been connected to an ullage pipe, is as follows:—

Assume a tank to be 98% full of water of specific gravity 1.0 when the float is lowered until it floats, the rate of which the float falls being controlled by the crank handle.

When the float comes to rest the reading on the graduated tape is noted and this reading represents "No ullage". In the case of liquids of lower specific gravity the float will, of course, float more deeply and a correction for gravity will require to be made. The height at which flotation occurs in liquids of different gravity is indicated on the side of the float and by adjusting the specific gravity scale the correct ullage will be shown on the tape.

As the liquid level in the tank falls the float maintains its relative position, and in proceeding downwards with the liquid level causes the graduated tape to be unwound, and a pull to be exerted on the tape reel. As the power reel is fixed to the tape reel rotation of the latter causes the constant force spring to unwind from the power reel and be wound upon the other reel.

When the liquid level, and with it the float, rises, the effect of the constant force spring is to maintain a light but uniform pull on the tape so that no slackness occurs and the ullage is accurately registered at all depths.

The invention has been described by way of example more particularly in relation to oil tankers but naturally it may be used with advantage in connection with other tanks and containers and with liquids other than oil.

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Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

848,988 COMPLETE SPECIFICATION

5 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

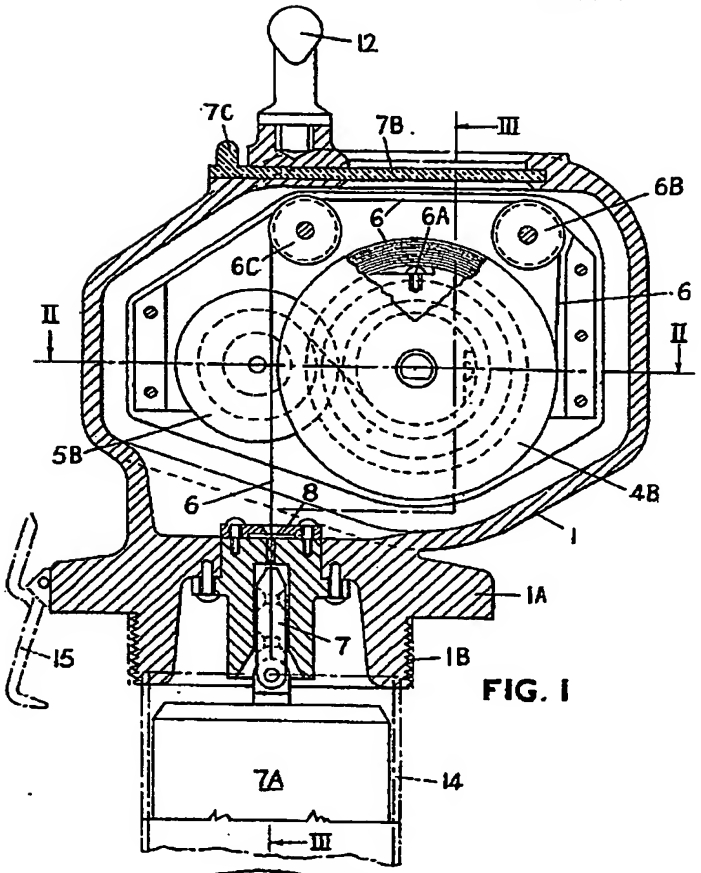

FIG. 1

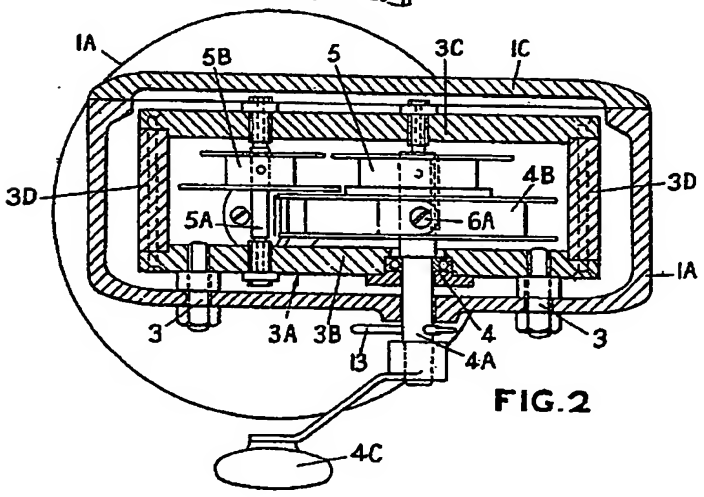

FIG. 2

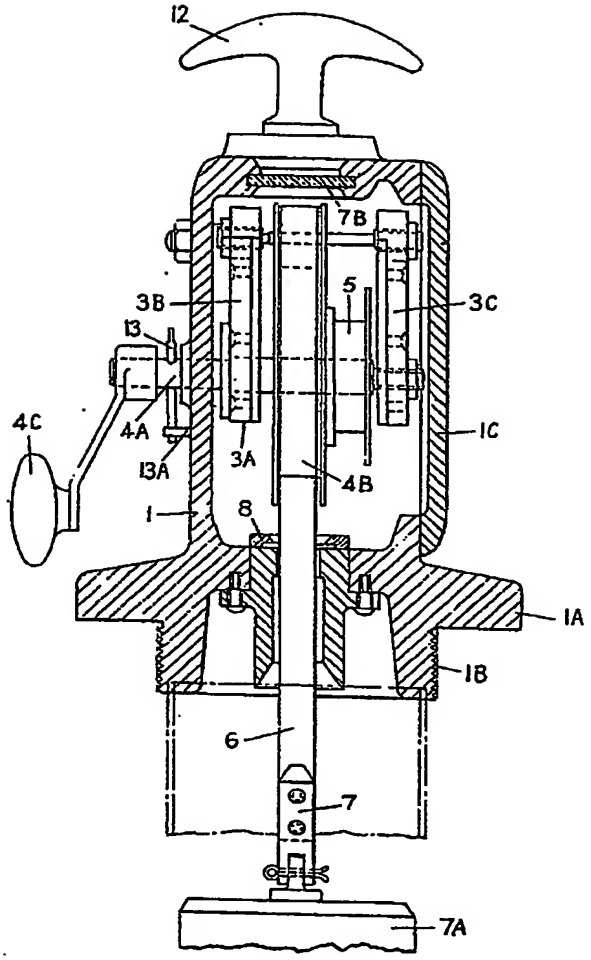

FIG. 3

848,988 COMPLETE SPECIFICATION

5 SHEETS

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SHEETS 2 & 3

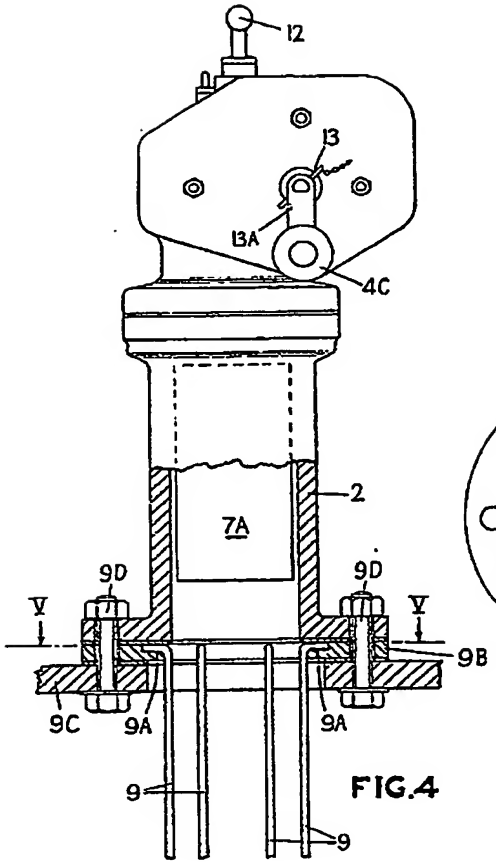


FIG. 4

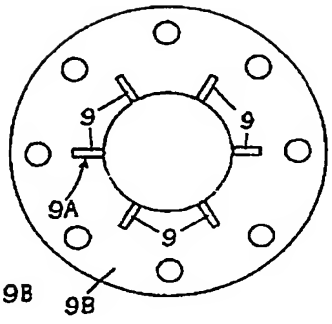
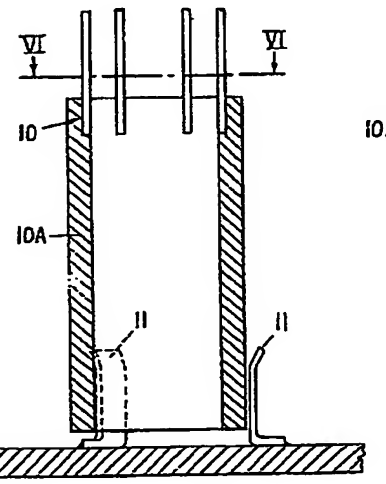


FIG. 5



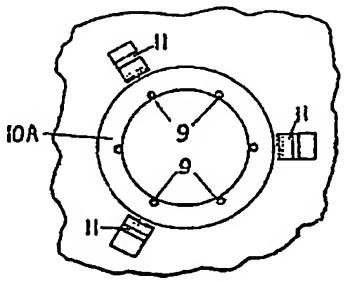


FIG. 6

848,988 COMPLETE SPECIFICATION
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SHEETS 2 & 3

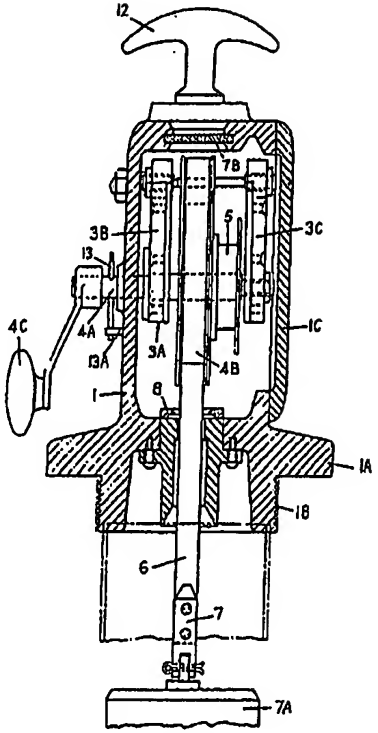


FIG. 3

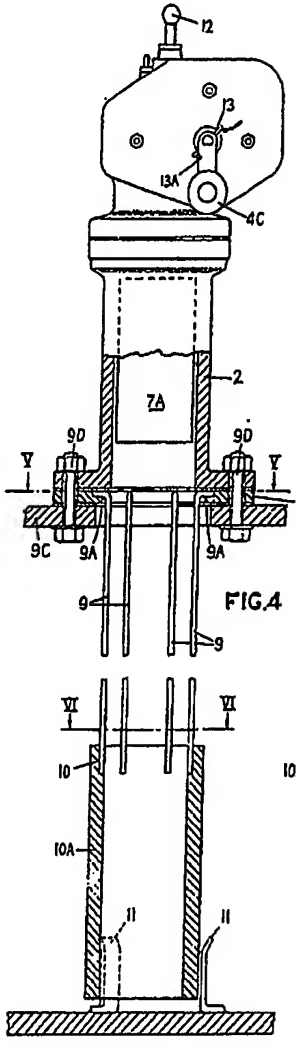


FIG. 4

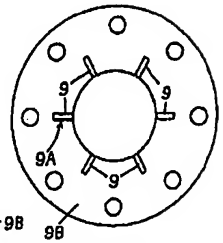


FIG. 5

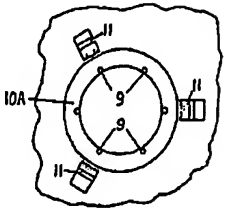
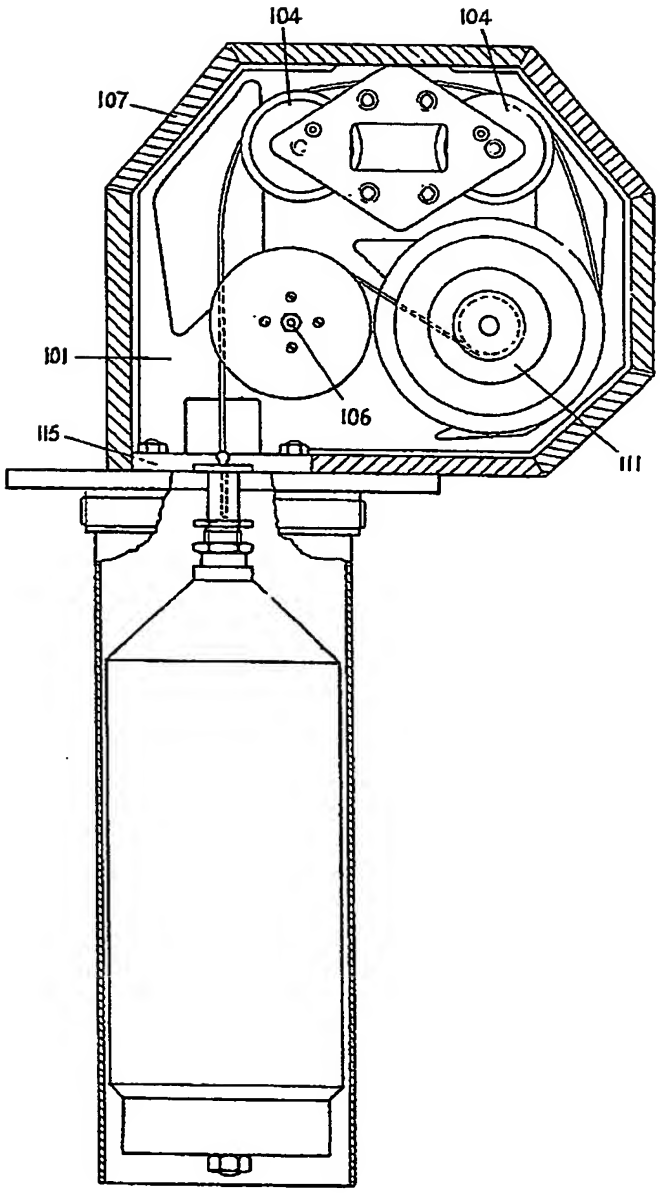


FIG. 6



848,988 COMPLETE SPECIFICATION
5 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 4 & 5

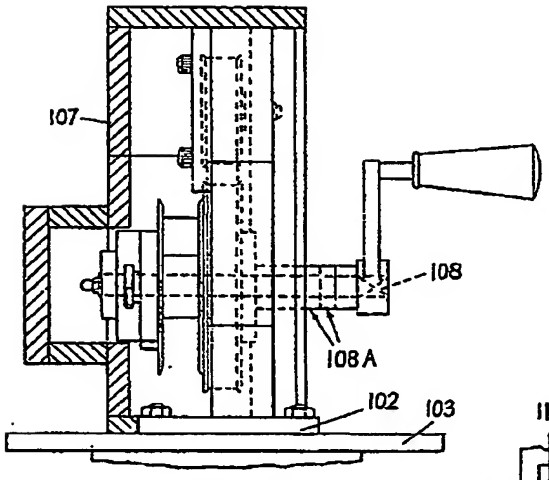


FIG.8

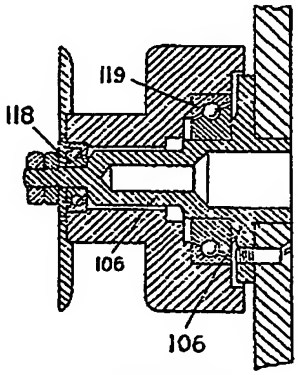


FIG.10

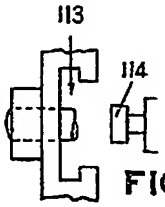


FIG.12

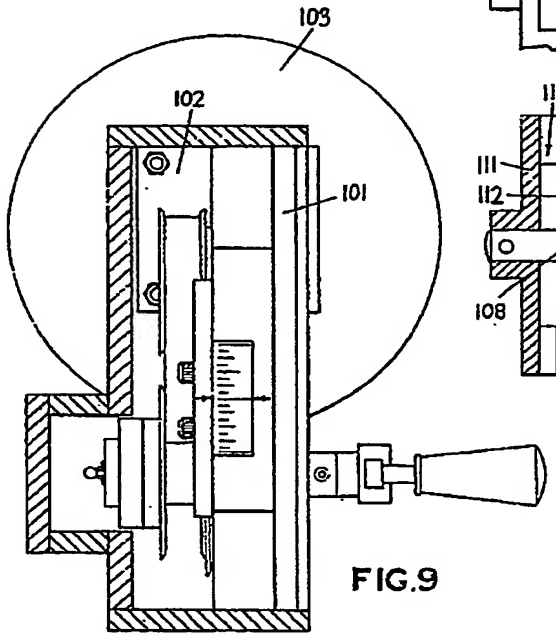


FIG.9

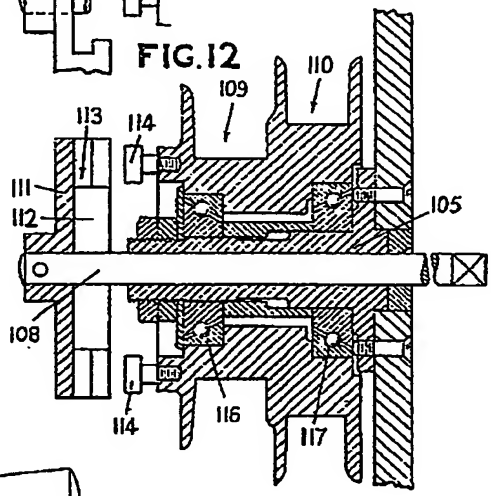
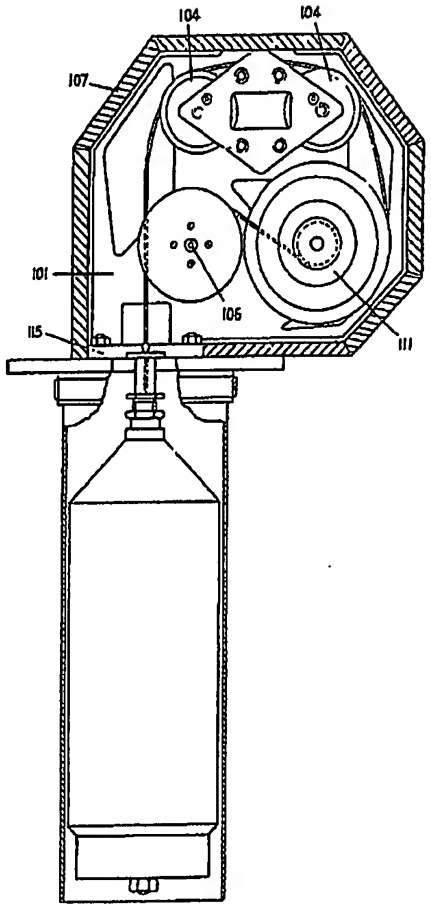


FIG.11

848,988 COMPLETE SPECIFICATION
5 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 4 & 5



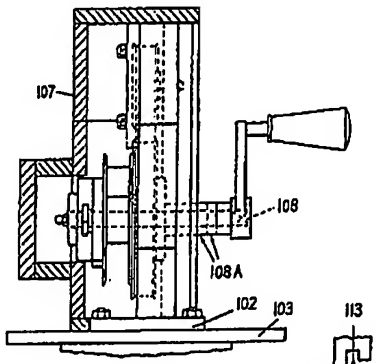


FIG.8

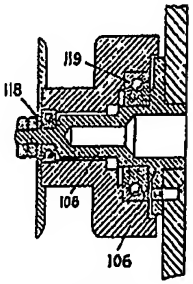


FIG.10

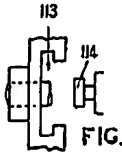


FIG.12

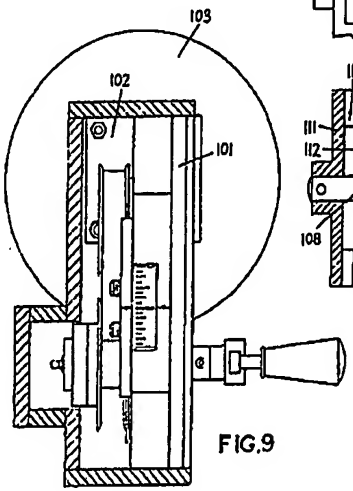


FIG.9

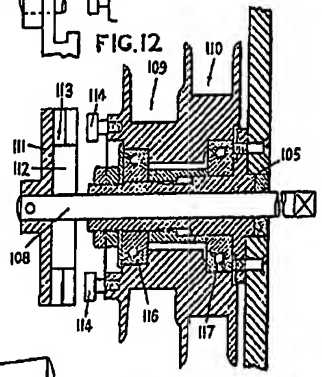


FIG.11